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ABSTRACT

Based on weekly reports sent via electronic mail, correspondence between sites, and bi-monthly audiotapes from teachers, this qualitative study analyses data from 32 elementary and secondary Apple Classrooms of Tomorrow (ACOT) teachers in five schools concerning management changes that occurred in teaching and learning in the new computerized classroom environment. The study covers the period from October 1985 through June 1989. Section one of the paper describes the survival stage of development in the ACOT teacher's management style, when teachers are overwhelmed by the necessity of controlling student behavior, organizing the physical environment, adjusting to the technical aspects of the instructional innovations, and redefining their role in the classroom. Mastery is discussed next. Occurring during the second year of the ACOT program, teachers begin to anticipate problems in student behavior, classroom environment, and technology, and develop strategies for solving them. The final stage, impact, occurs when teachers successfully utilize the technology for managing the classroom and focus on their effectiveness as teachers. It is concluded that teachers learned to use the technology to enhance student motivation, interest, and learning, and incorporated technology in their teaching in such a way that they now could not imagine teaching without it. (15 references) (DB)

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Teaching in High-Tech Environments: Classroom Management Revisited

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Prepared for a presentation at the 1990 meeting of the American Education Research Association, Boston.

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A Project of the Advanced Technology Group
Apple Computer, Inc.

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TEACHING IN HIGH-TECH ENVIRONMENTS: CLASSROOM MANAGEMENT REVISITED

Judy Haymore Sandholtz
Cathy Ringstaff
David Dwyer
Apple Computer, Inc.

> If I had my druthers, I don't think I would ever look at a computer again. One of my students got into the Corvus network and lost lots of information because he doesn't know what he is doing. It's a typical situation, and it's caused a major problem because now the computers are down. There are so many variables like this that we deal with on a day to day basis that I didn't anticipate being part of this program. I'm anxious for the weekend so I don't have to do anything with computers (AT, Nov. 16, 1988).[1]

Every teacher has an occasional bad day. But few teachers identify a student's experiments on a Corvus network as the source of their frustrations. John Erickson is one of 32 teachers across the country teaching in a high-access-to-technology classroom for the entire school day. In 1985, Apple Computer began a collaboration with a number of schools throughout the country to investigate learning and teaching when children and teachers have access to interactive technologies. In five of these schools, students and teachers in Apple Classrooms of Tomorrow (ACOT) were provided with an individual computer both at school and at home. Consequently, teachers at these sites have spent more time teaching in immediate-access-to-technology environments than any other teachers in the world.

Although the majority of these teachers brought years of teaching experience to their jobs, the introduction of computers into their classrooms significantly altered their teaching environments. In many ways, the teachers

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[1]The data notation system used throughout this paper indicates the source of the data (AT = audiotape data; WL = weekly reports sent via electronic mail) and when the data were generated.

felt like novices again. Neither John nor the other teachers completely anticipated the range of student misbehavior, the changes in the physical environment, the shift in the teachers' roles, and the technical problems that would accompany the new technology. Nor did they anticipate how quickly they would learn to utilize the technology to their advantage in managing the classroom in areas such as grading, recordkeeping, individualizing instruction, and developing new materials. Whereas in the beginning of the project teachers sometimes thought only of how the technology increased their workload, before long many teachers doubted they could ever return to a traditional classroom. This paper describes how teachers moved from frustration to success in coping with the changes brought about by the introduction of computers to their classrooms.

While preservice education typically includes teacher training in classroom management techniques, little is known at this time about management in high-access-to-technology environments. Most research offers few suggestions to practitioners faced with teaching in a classroom filled with computers, networks, laser discs, printers, and other technological tools. Instead, the research articles that do exist on this topic make recommendations related to school computer laboratories or classrooms with one or two computers.

For example, researchers (Amarel, 1983; Ragsdale, 1983) discuss the logistical difficulties of scheduling computer time for 25 to 30 students when only two or three computer terminals are available. In an article recommending changes in teacher education to reflect the use of computer technology, Hoffman (1984) warns: "The teacher has to devise some plan for scheduling usage so that every student has an opportunity for hands-on experience" (p. 22). In contrast, ACOT teachers had more trouble keeping the students off the computers than ensuring equal opportunity for student use. Thus, the present literature does not address situations where teachers and students have high access to technology throughout the school day.

Some literature has greater applicability to both types of computer classroom settings, such as position papers that call for improvement in teachers' computer literacy (Leonard & LeCroy, 1985) or that make suggestions for curriculum integration (Ragsdale, 1983). Additional articles present information about topics that are clearly relevant for any classroom using technology, such as software and hardware selection (Worthington School

District, 1983); computer equipment maintenance (Guerrero & Eisler, 1986); and recordkeeping on the computer (Killoran, 1987). However, most are directed at teachers working in environments that are qualitatively different than ACOT. Yet, as technology becomes more affordable for school districts, high-access-to-technology classrooms may become more of a reality than an experimental setting.

This paper highlights three main issues relevant to practice and research. First, classroom management is not a skill that is mastered once and for all. As the classroom context changes, so do the classroom management issues. In this paper we describe how experienced teachers, after a dramatic change in the classroom environment, found that "tried and true" management principles no longer worked. Learning from the experiences of the ACOT teachers, others using even a minimum amount of technology may be able to avoid some of the initial problems that occur in classrooms utilizing technology, particularly because the sheer number of computers in ACOT classrooms made technology-related problems highly visible. Second, this paper provides further support to the belief that educational change takes time. Before the benefits of change emerge, and the innovation takes hold, teachers tend to focus on the increased workload and the drawbacks associated with the innovation. Finally, this paper illustrates that teacher change is not unidirectional. Teachers progress through stages of concern in an idiosyncratic manner.

SETTINGS

This qualitative study utilizes data from thirty-two elementary and secondary teachers in five schools located in four different states. The ACOT schools represent the diverse populations and conditions found in contemporary public schooling. Each of these sites began with one classroom in the fall of 1986, adding classrooms, staff, and students in subsequent years. Table 1 summarizes the status of each site in the spring of 1989.

Site	Grades	Teachers	Students	Community/SES
1	1-4	8	180	Suburban/High
2	5-6	7	180	Rural/Middle
3	4-6	4	90	Inner-City/Low
4	4 & Sp. Ed.	4	80	Suburban-Urban/Low-Middle
5	9-12	9	120	Urban/Low-Middle

Table 1: Site Descriptors

In each of these settings, students and teachers have constant access to interactive technologies. The elementary classes are equipped with Apple® IIe, IIGS, and Macintosh® computers. The high school is an all Macintosh installation. In addition to the computers, classrooms are equipped with printers, scanners, laserdisk and videotape players, modems, CD Rom drives, and hundreds of software titles.

The technology is used as a tool to support learning across the curriculum. No attempt is made to replace existing instructional technologies with computers. By design, the classrooms are true multimedia environments where students and teachers use textbooks, workbooks, manipulative math materials, white boards, crayons, paper, glue, overhead projectors, televisions, pianos, etc. as well as computers. The operating principle is to use the media that best supports the learning goal.

DATA COLLECTION AND METHODOLOGY

The sources of data for this study, covering from October 1985 through June 1989, include weekly reports sent via electronic mail; correspondence between sites; and bi-monthly audiotapes on which teachers reflected about their experiences.

Weekly reports and site communications were transcribed verbatim, and audiotapes were summarized. To facilitate analysis, narratives were divided into episodes; each episode represents an event, with a beginning, middle, and end. Episodes were indexed for retrieval using a variety of categories and subcategories (e.g., participant, affective tone, context, general theme).

The complete database includes over 13,000 episodes. Double Helix, a relational database, was used to manage and analyze the data. This software program allows data to be organized in a multitude of ways (e.g., by teacher, by school site, by thematic categories). For this paper, data were organized longitudinally to examine changes in teachers' classroom management concerns over time.

Although the data were analyzed longitudinally, we found that simply examining the data in terms of chronological dates was misleading for a variety of reasons. First, while this project spans almost four years, some of the teachers represented in the database were not involved for this entire time. Understandably, management concerns were often different for teachers joining the project at its inception (1985) than for teachers who began teaching in ACOT during the most recent year of data collection (1989) when the project was well underway. Also, each year of the project sometimes brought about changes in site organization, in the types of equipment that was available, or in project goals. Moreover, at some sites, teachers worked with the same students over several years, while at other locations teachers had to start each year with brand new students. Thus, rather than examining change within individual teachers over time, we viewed the data as a "collective consciousness," documenting general trends related to classroom management concerns during the evolution of the project.

CONCEPTUAL FRAMEWORK

A Concerns-Based Model of Teacher Development

Data collected for this study provide an opportunity to examine classroom management using an adaptation of Fuller's (1969) concerns-based model of teacher development. According to Fuller, there are six different levels of concern that preservice teachers express at different points in their teacher training programs. These levels range from initial concerns unrelated to teaching, to concerns about oneself in relationship to teaching, to concerns about the impact of teaching on students.

Subsequent research examining teacher concerns (Hall, Wallace & Dossett, 1973; Hall & Rutherford, 1976; Hall & Loucks, 1979) suggests that the concept of teacher concerns can be similarly applied to teachers involved in implementing various educational innovations. Hall and Loucks (1979), for example, propose that during the first stages of implementation of an innovation, an individual's concerns focus on learning more about the innovation's general characteristics and the impact the innovation will have on his or her role within the organization. Eventually, management concerns take precedence, in which the individual focuses on the processes involved

in using the innovation. Finally, the individual will begin to have concerns related to the impact of the innovation; he or she will attend to the relevance of the innovation for students, collaboration with others regarding the use of the innovation, and improvement upon the innovation.

The developmental model proposed in this paper includes three stages of teacher concerns related to classroom management: survival, mastery, and impact. In the first stage, survival, teachers are preoccupied with their own adequacy. Their concerns in this stage typically center on themselves and their ability to maintain control over the classroom and the students. In a completely new classroom environment, teachers who are concerned with their "survival" spend a considerable amount of time reacting to problems instead of anticipating and avoiding them. In the second stage, mastery, teachers begin not only to anticipate problems but to develop strategies for solving them. Finally, in the last stage, impact, teachers focus on the effects of their teaching on students and begin to utilize the technology to their advantage in managing the classroom.

Like most stage models of development, the conceptual framework in this study posits that change is an idiosyncratic and unsystematic process (Lieberman and Shiman, 1973). Individuals may express concerns related to more than one stage simultaneously, or vacillate between instructional phases. For example, as early as the second year of their participation, most teachers learned to expect occasional technological problems, such as disk failures or network bombs, and planned accordingly. Yet, when new software, new hardware, or new students arrived on the scene, many teachers temporarily reverted back to the survival stage.

The Relationship between Classroom Management and Classroom Instruction

This paper deals primarily with classroom management rather than instruction. However, the line between the two is not always clear-cut. Therefore, it is important to consider what was occurring instructionally in the ACOT classrooms while teachers were struggling with classroom management issues.

Although the sheer number of computers in ACOT classrooms radically transformed the physical environment, for the most part instruction remained unchanged in early years of the project. Gradually, however, new patterns of

teaching and learning emerged at all sites. It is relatively easy to view this progression as an evolutionary process that is similar to other models of educational change (e.g., Berman & McLaughlin, 1976; Giacquinta, 1973; Gross & Herriott, 1979). We have labeled the stages of instructional evolution in the ACOT classrooms: Entry, Adoption, Adaptation, Appropriation, and Invention. (See Figure 1, p. 8). In this model, text-based curriculum delivered in a lecture-recitation-seatwork mode is first strengthened through the use of technology and then gradually replaced by far more dynamic learning experiences for the students. (For a more thorough treatment of the changes in instructional practices, see Dwyer, Ringstaff, & Sandholtz, [1990].)

In the earliest stages of the project, ACOT teachers demonstrated little penchant for significant instructional change and in fact, were using their technological resources to replicate traditional instructional and learning activities. Even into the Adoption phase, students continued to receive steady diets of whole-group lectures and recitation and individualized seatwork. As teachers eventually reached the Appropriation phase--the point at which an individual comes to understand technology and use it effortlessly as a tool to accomplish real work--their roles began to shift noticeably and new instructional patterns emerged. Team teaching, interdisciplinary project-based instruction, and individually-paced instruction became more common at all of the sites.

In comparison to this gradual instructional shift, changes in classroom management were, by necessity, immediately required to establish order in these radically different teaching environments. As Figure 2 illustrates, teachers moved through the developmental stages of survival, mastery, and impact more quickly than through the instructional phases. This data suggests, as do other studies related to classroom management, that instructional innovation and change is not likely to occur in classrooms until teachers have achieved a significant level of mastery over management issues.

RESULTS

Stage One: Survival

An important concern of teachers in the survival stage was their ability to anticipate problems. The teachers in this study frequently found

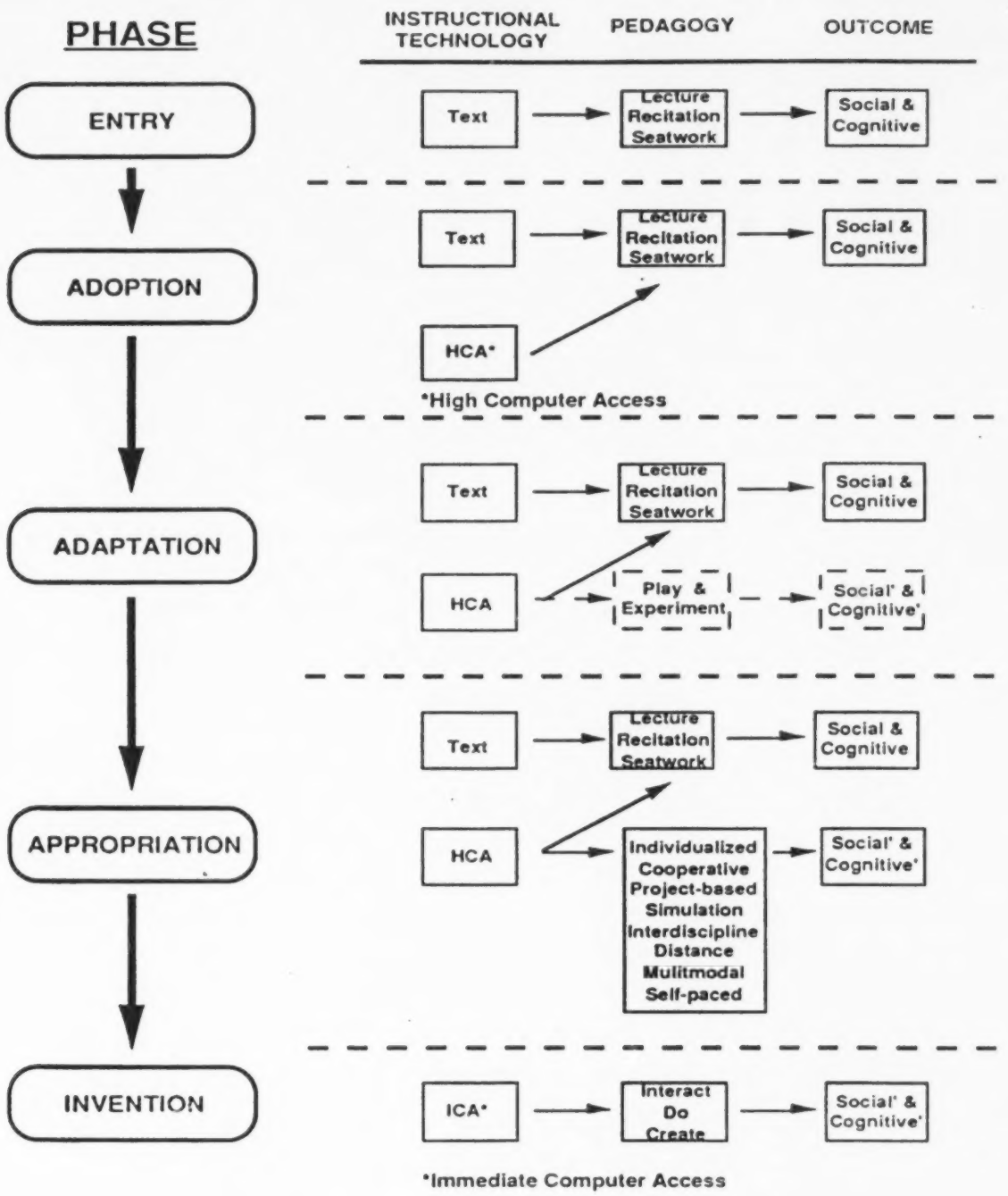

Figure 1: Instructional Evolution in Technology–Intensive Classrooms

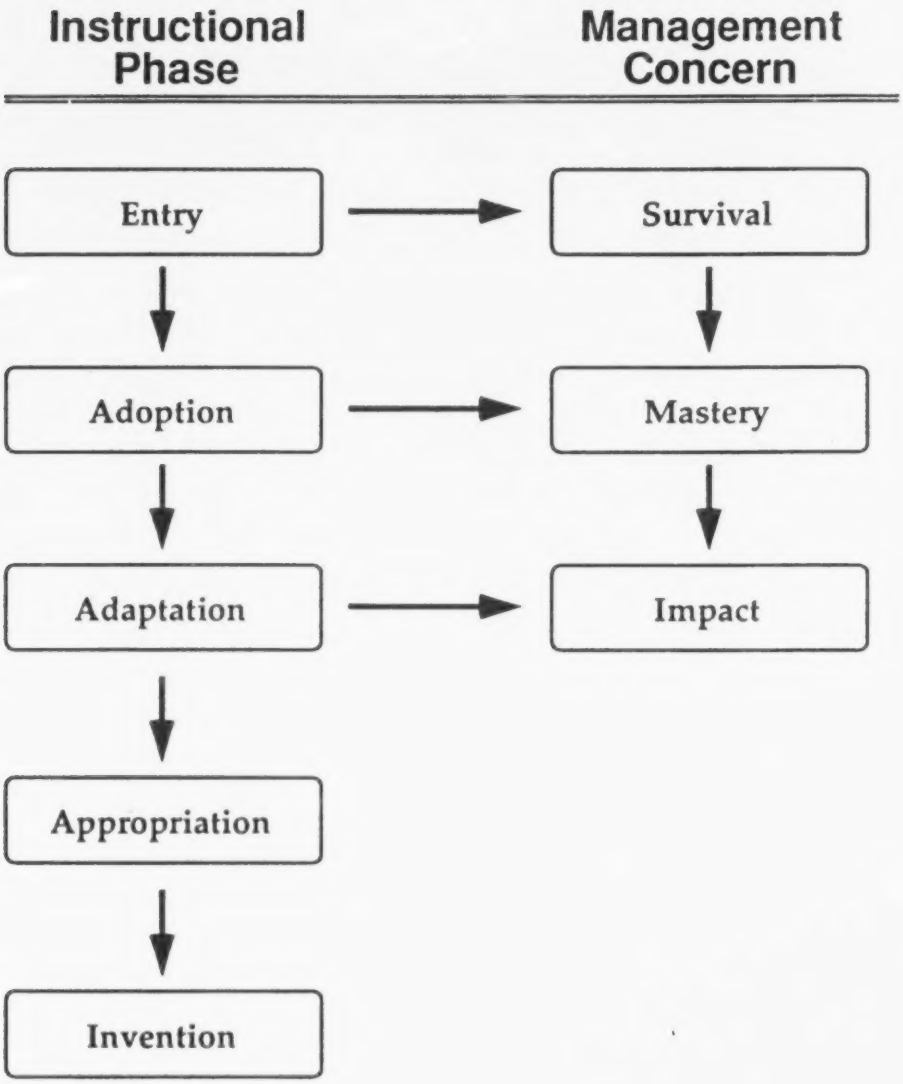

Figure 2: The Relationship between Instructional Evolution and Classroom Management Concerns

themselves unable to anticipate problems in their high-technology classrooms. Data analysis revealed a common pattern of problems across teachers and generated the following categories: student misbehavior and attitudes; the physical environment; technical problems and software management; and the dynamics of the classroom environment.

Student Misbehavior and Attitudes

Although adding technology to the classroom initially had little effect on teachers' instructional behaviors, the introduction of computers to classrooms opened up a whole new realm of student misbehavior. As students learned to use disks and software, some also discovered how to illegally copy software, how to protect their disks from teacher access, and how to sabotage other students' work. In the words of one teacher, the computers provided "a real opportunity for the freshmen to irritate the sophomores" (AT, Dec. 7, 1987). Seemingly innocent classroom activities became an opportunity for student misconduct. For instance, during a telecommunications activity with a class at another school, students began exchanging insults. With the interactive technology, the teacher had no opportunity to preview, and censor if necessary, the students' messages.

New methods for cheating also accompanied the new technology. Knowing that the teacher could no longer rely on handwriting to distinguish an individual student's work, some students simply stole other people's disks and tried to relabel them for themselves. Another common tactic involved taking someone's disk, copying work, and returning the disk to its original spot.

> I discovered that the students had copied other students' data without the students knowing it -- by using the disk before class. The Mac makes it much easier to cheat. In five to ten seconds, a student can copy work and not even know what it said (AT, Nov. 2, 1987).

Other students, described by the teachers as "computer wizards," used more advanced techniques for cheating. For example, one student figured out how

to get 100 percent on the computerized algebra test without working through any of the steps on his scratch paper.

> When he held up his hand to say he was through after twenty minutes, I went over to check, but he had done nothing on the scratch paper. . . I had him go over the problems with me to show how he would do them, but he could really do only about 20 out of the 60 or 70 (problems) on the test . . . Somehow Jim has figured out how to get the 100 percent in the computer without doing the work to earn it (AT, June 9, 1988).

In many cases of student misbehavior, the actions stemmed from the children's inquisitive nature. For instance, the teachers found out that the students had been taking apart the mice to see how they work. However, in putting them back together, parts would invariably end up missing. Other students experimented with magnets to see "if it really does erase a disk." "It did," reported a disgruntled teacher. Some students discovered how to read the telecommunications files of the teachers, and, in one classroom, a student announced to the rest of the class how to get into the teacher's management system. While the teachers admired the students' curiosity, they decried the results of the students' misguided adventures. One of the most frustrating situations for the teachers occurred when students, intentionally or unintentionally, caused problems with the computer network system. Network damage affected the entire class, disrupting the instructional activities. Frequently, a network problem shut down all of the computers in the classroom.

> One of our students got into our Appleworks network system -- that part that decides what part of the program you put into the memory. It fouled up the network so none of the students could get onto the network. Lots of our projects couldn't be done. These sorts of things have been happening all year long, and I'm really tired of it. It shows that the students aren't being responsible or taking into account that what they do can affect other people (AT, Dec. 5, 1988).

The teachers also found themselves unable, in the beginning, to predict student attitudes about working with the computers. The students became so enamored with the computers that they became unwilling to do work with paper and pencil when their classroom or home computers were broken. Several of the software programs intrigued the students to the point that they openly resisted when teachers decided to move on to other activities. As one teacher analyzed the problem, the difficulty stemmed from "trying to fit open-ended software into a time-structured environment" (AT, Jan. 13, 1987). In addition, the availability of software at individual workstations allowed students "too much control" over what they elected to do. The tempting software and the allure of the computers made it difficult for students to concentrate on other types of classroom activities.

> Study time is a problem time. They think that just because that computer is sitting there, they have to have their hot little hands on those keyboards . . . They just get on the computer and anything they can call up they have to have their hands on it (AT, Nov. 8, 1988).

> I've found that when the computers are on, the students not using them have a very difficult time maintaining their concentration on whatever else they're doing -- even if their backs are to the computers (AT, Dec. 2, 1988).

The computers became not only a source of distraction for the students but also physical shields to hide their off-task behavior. Even high school students could "hide behind their computers" in order to talk to each other or to avoid working on the assigned task. In addition, the use of home computers provided students a host of new excuses for not completing their homework.

> I am having trouble with many students in this class blaming the computer for their lack of preparation. I went over again step-by-step how to save work to a disk. They can no longer use that

> excuse since they've had six weeks to learn the procedures (AT, Oct. 3, 1988).

Hardware problems on the home computer became the most typical excuse. One teacher, after finally catching on to the scheme, started keeping a record of all the excuses given by the students.

The Physical Environment

The addition of computers to the classroom also created a number of problems related to the physical environment. For instance, the classroom lighting and the glare from the windows hindered the students' ability to produce digitized pictures and to use the PC Viewer for presentations. Chalk dust, a common element in most classrooms, gathered in the keyboards and computers resulting in problems. Power outages caused major disruptions in classroom activities, and sometimes students experienced unexplained electrical interference on the computer monitors. Extremes in the weather played havoc with the classroom computers. Hot weather caused computers to crash in schools without air conditioning, and fans did little to alleviate the problem. Powerful rainstorms flooded several of the classrooms, damaging some equipment and making it dangerous to turn on the computers. At one school, the weather created a static electricity problem.

> We had an exceptionally bad time with static electricity . . . I am concerned that we are going to lose some disks; we have already lost one. I've really talked to the kids about grounding themselves before they touch anything, and I hope it sinks through (AT, Dec. 15, 1988).

The teachers also expressed surprise and frustration at the extra time spent setting up and arranging equipment. Besides the initial set-up of the classroom, teachers found themselves dismantling the computers for repair of the tables, rearranging the equipment for special projects, setting up new desks, and disassembling and reassembling the classrooms because of changes in room assignments. Teachers who had become accustomed to neat and orderly classrooms became bothered by the clutter and the crowded classroom arrangement that occurred with the addition of computers, printers, cables,

disks, papers, and other related paraphernalia. Since the computer-centered instruction increased the need for teachers to move around the room and provide individual attention to students, the teachers felt hindered by the increasingly crowded classroom conditions. As one teacher phrased it, "I am constantly tripping over technology of some sort; the room is just not big enough to hold everything that we need for it" (AT, March 29, 1989). Given these additional demands, the teachers became particularly annoyed when other groups, such as community service and senior citizen classes, used their classrooms and left them in disarray.

The changing physical environment of the classroom also made it more challenging to organize various instructional groupings. Several teachers expressed frustration when trying to arrange coherent group work with the computers. They could no longer simply rearrange some chairs and desks or tables into group settings.

Technical Problems and Software Management

In most non-laboratory classrooms, teachers infrequently encounter technical problems during their day-to-day instruction. On those occasions when they might use audiovisual equipment, they typically have to worry about one piece of equipment, and if they experience problems, it is fairly easy to shift plans. By contrast, the teachers in the ACOT classrooms encounter numerous technical problems because of the amount of equipment they deal with every day. And since their instruction is computer-centered, technical problems upset both their daily and long-range plans. During the nearly four year period of this study, the most frequent complaints lodged by the teachers related to technical problems.

At the beginning of the project and the beginning of each school year, the teachers became frustrated by delays in the arrival of equipment. Students who had been anxiously anticipating the first day of school openly displayed their disappointment when they entered an "empty" classroom. At many of the sites, none of the home computers were distributed until all of them had arrived. Consequently, teachers also had to contend with the queries of annoyed parents.

The lack of equipment disrupted the teachers' instructional plans for classroom activities and student homework. Without the necessary

equipment, the teachers' innovative ideas were put on hold and the curriculum bogged down.

> I especially want the students to get computers to use at home. . . I feel like we are going at a snail's pace. We spend so much class time on typing and printing when they could be working at home and just bringing in disks to print (AT, Oct. 18, 1988).

> (Lack of equipment) has been a tremendous burden for teachers on the firing line. It is like sending troops into battle and telling them the rifles will be there in two months. In business, when equipment is not there, you can turn to other work, but a teacher cannot and must keep backing up and regrouping (AT, Oct. 17, 1988).

Frustrations from a lack of equipment didn't end completely with the arrival of the computers. Throughout the school year, teachers dealt with the periodic inconvenience of having computers out for repair. The repair technicians at the local computer stores didn't seem to share the teachers' sense of urgency, so repairs typically took a period of weeks. When students were without home or classroom computers for that length of time, they fell behind in their work. Since the curriculum was designed around individual computers for each student, sharing computers proved to be an inadequate substitute.

> I have children assigned as share partners on the computers since we have only 11 computers and 15 students. I can actually see the children who are sharing falling behind the other students. Their self-concept is being jeopardized as well since they feel out of place (AT, August 18, 1988).

> A keyboard repair came back today, and the student was overjoyed to be able to use her computer at home again. Still, there are four students who cannot use their home computers due to repair problems (AT, Sept. 23, 1987).

The teachers also encountered various technical problems with the printers. The most common problem was that the printers frequently jammed, increasing the time needed to get student assignments printed out. The teachers also noted that the number of printers didn't always match the demand, creating a bottleneck.

> Printers have been jamming up, there are fewer of them in the room, and they require constant attention to get assignments printed out. It took 20 minutes for one group of 30 students this week (AT, Sept. 30, 1987).

Delays in receiving printer cables and in getting needed repairs compounded the problem.

> We are still waiting for cables for printers . . . This is slowing things down noticeably, and we have had to go from three students per printer to five students per printer. It takes about 25 minutes for one complete class printout while last year it took four or five minutes (AT, Sept. 23, 1987).

Since the students did most of their assignments on the computers, they had a large volume of work that needed to be printed out. The heavy use of the printers and the variety of people using them seemed to contribute to the frequent malfunctioning and breakdown of the printers.

When numerous students tried to print at the same time, a backlog of printing jobs resulted. However, when many students in the class simultaneously tried to log or save onto the computer network, a new problem emerged -- a network jam or breakdown. In one of the classrooms, the problem occurred more frequently on one side of the room than the other because of the uneven distribution of desks and computers. Network problems were serious for the teachers because they rarely had the expertise to fix the problem themselves and because their lesson plans were totally disrupted.

Introducing computers into the classrooms meant that the teachers had to deal with new instructional tools --software and disks -- and the accompanying "bugs." One of the most frustrating problems resulted from

some sort of incompatibility between the software and the computers or printers.

> The assignment on Magic Slate ran all right on the GF printers but the IIE printers caused problems. Some students could complete the work and some could not. It was really frustrating and not a happy sight to say the least (AT, Sept. 28, 1988).

Sometimes software programs would "lock up" because of an error by the teacher or student in entering information.

Teachers encountered a variety of management concerns related to software and disks beyond the technical problems. Software frequently arrived late, and copyright restrictions made it difficult to acquire enough classroom copies for student use.

> This year we have a new spelling series which has software that coordinates with each lesson. Unfortunately, the software is copyprotected; we have not been able to reach the salesman (WL, Sept. 12, 1986).

In one case, the schools purchased software that didn't meet the advertised claims, and the company responded by telling the teachers to wait for a new release. At several locations, the local suppliers were unable to keep enough disks in stock to meet the demands of the ACOT classrooms. Some teachers became overwhelmed by the sheer number of disks and programs they had to work with.

> One of the things which slows us down is the constant booting of disks, the constant need to find which one of 500 floppies has the information I want. That is a real chore (AT, March 8, 1988).

Dynamics of the Classroom Environment

Another concern of the first stage centered on teachers' abilities to understand the dynamics of the classroom environment. Many teachers

initially were troubled by the increase in noise level resulting from the printers, the keyboards, and the necessity for students to move freely around the classroom.

> Sometimes the screech of the printers is absolutely maddening in the classroom. I can't do anything until the printers are off (AT, March 29, 1987).

> There is a great deal of freedom in the way the work is set up, which leads to a lot of noise and talking (AT, Sept. 15, 1988).

Having become accustomed to the structure of students sitting in their seats and the teacher up in front of the classroom, some teachers worried whether the students were on task and learning.

> I wonder if they are really on task with the teachers just moving around the room. I am also concerned about whether the students can really learn without me up front in charge. It takes getting used to (AT, Sept. 15, 1988).

> It is hard to allow the kids the freedom they need to move about the room for individual and group work (AT, Sept. 21, 1988).

In some cases, teachers in this study found themselves faced with knowing less than their students about hardware or software, upsetting their traditional views about teacher role. While some teachers felt threatened by that situation, others described it as exciting and were inspired to increase their own knowledge.

> I am not a sophisticated Hypercard user at all, and it took me a long time to get ready to teach the unit. I had to ask many questions of my colleagues and really practice at home. I learned enough, just enough, to get them through that lesson . . . By the middle of the second day, the kids were ahead of me. They took it home and worked on it and came in with all kinds of ideas to use its capabilities. It was frustrating but it was exciting! It really forces you to move ahead if you are going to use

> something like this as a tool with the kids (AT, Feb. 21, 1989).

Since computers facilitated independent learning, some teachers felt that they were no longer teaching and suggested that the classrooms had become "technology centered, not instruction centered." They wondered if they were accomplishing their main goal of "teaching the students the content."

> I panicked today when I realized I hadn't taught the kids all the required algebra. It's because, in the beginning, we had to spend so much time with computer stuff. I know they're really learning the material and what they're learning about computers is priceless. However, I still didn't teach them what is required (AT, March 11, 1988).

One teacher pointed out that, although she wanted to take advantage of the alternative teaching styles available to her, she found herself falling back into "the old way because it's easier and saves me time" (AT, June 2, 1988).

The computer centered instruction also changed the traditional role of substitute teachers and parents. Many substitutes, overwhelmed by the classroom environment, failed to follow through with the teachers' lesson plans and reverted to non-computer activities. While some parents felt comfortable working with their child and the home computers, others felt insecure about supervising homework on the computer. This posed a challenge for teachers who depended on homework as a reinforcement for classroom activities.

Summary

Data analysis suggests that teachers in high-access-to-technology classrooms, like novice teachers, were initially concerned with issues such as controlling student behavior, organizing the physical environment, and defining their role in the classroom. During this survival stage, teachers felt unprepared to deal with such issues as students copying or stealing each others' disks, or with the difficulty of tearing students away from certain

software programs. The addition of technology added new demands in terms of the physical environment as well--teachers had to cope with such problems as lack of space, inadequate lighting, and weather that disrupted the flow of classroom activities. Delayed or broken equipment, noisy or bottlenecked printers, and software bugs added to teachers' frustration. Finally, some teachers had difficulty adjusting to a situation in which they were no longer the all-knowing expert standing in front of the classroom to dispense knowledge. Faced with such problems, it is not surprising that teachers focused their energies on changing their classroom management strategies rather than on becoming instructionally innovative. Yet, typically by the second year of their participation in the project, the intensity of teachers' concerns with survival decreased, and they moved into the second stage, mastery.

Stage Two: Mastery

In this stage, teachers began not only to anticipate problems but also to develop strategies for solving them. When problems occurred, teachers were now able to make necessary changes.

To deal with student misbehavior, teachers developed strategies aimed at the specific problems. Since the computers were both a prime attraction of the students and a source of misbehavior, many teachers started to restrict the use of computers. In most cases, individual students lost their computer privileges for a period of time; but, in some rare instances, teachers imposed group restrictions.

> We do not have the computers on before school, during lunch, or for study hall at the end of the day as a punishment for illegal copying (AT, Feb. 22, 1988).

In one severe cases, the school principal suspended students from school for several days or removed them from the ACOT program.

As the teachers caught on to the variety of cheating schemes, they adopted strategies such as confronting each student individually, holding class discussions on ethics, and imposing grading penalties. But some teachers became as ingenious in devising solutions as the students were in finding

ways to cheat. These teachers figured out how to use the technology to catch the culprits and stifle recurrences. For example, a high school class had been given an "Insect Collection and Database Assignment," and a number of students appeared to have copied data from one disk to another.

> Technology comes to the rescue of the teacher by allowing the teacher to become aware of the 'sharing.' When Bill merged all the students' databases into one massive database, he was able to sort on various fields. For example, if he sorted on the 'Common Name' field, it became apparent that several students found 17-year cicadas on August 22 at Rocky Fork Country Club at 12:00 p.m. The insect is lying on the ground in a forest -- sleeping. It's like playing the game 'What's wrong with this picture?' Other than time is not indicated by 12:00 p.m. (or a.m.), cicadas are tree insects (not ground), and don't sleep in the daytime. It also makes one wonder how all those students happened to be at a country club in another part of town all at the same time. The students quickly admitted the error of their ways when Bill showed the merged database to them (WL, Nov. 4, 1987).

The technology also came to the aid of a teacher searching for a way to keep his curious students from finding the built-in answers to his computerized tests. Since some of his students delighted in the challenge of discovering the solution keys, he scrambled to learn more and more about the software. Eventually, the teacher came up with a strategy -- assigning a global variable to the scoring portion of the test -- that he felt confident would keep the students out.

In dealing with problems related to the physical environment, the teachers encountered more limited solutions. In some cases, the ACOT classes could be moved to more spacious classrooms, but, more frequently, the teachers could do little about the size of the classroom itself. Consequently, teachers arranged classrooms to allow for the greatest amount of free space, and they developed systems for organizing and storing disks, printer papers, software, and other computer items. For some problems, teachers requested changes in the physical features of their classrooms. For example, teachers made proposals for glare-proof windows and static-free carpeting. After a

successful test trial, whiteboards replaced chalkboards in the ACOT classrooms in order to reduce the amount of chalk dust.

To counteract the amount of time spent setting up and arranging equipment, some teachers started to enlist student help in setting up the computers and the furniture. They reasoned that this would also help the students in setting up their home computers. At one site, the coordinator scheduled a full week of planning time before school started to set up the rooms.

> We really feel we're off to a smooth start this year. We took a week of planning time before school began to get ready and that really helped. All the rooms are up and running with combinations of IIe's and IIGS's this year (WL, Sept. 9, 1988).

Technical problems continued to plague the teachers throughout the four years of this study. Although some sites and some teachers successfully reduced the number of technical problems, no one completely eliminated them. Given the number of computers and the frequency of use, technical problems became a fact of life in the ACOT classrooms. The most ideal solution for dealing with technical problems occurred at one site which employed an on-site computer technician.

> So far on the home scene, we have had one monitor (in its third year of use) go bad. At school, we either don't have very many problems, or we don't notice them. Our technician has most repairs done in a half hour, so the down time isn't long enough to become irritating (WL, Nov. 30, 1987).

However, not all of the sites could afford such a luxury. Consequently, most teachers developed alternate lesson plans to use when the computers were down. With experience and increased knowledge of computers and software, teachers and coordinators gradually became more adept at avoiding problems and, when problems did occur, narrowing down the source of the difficulty. One teacher, after completing computer repair training, was delighted to discover that he could solve problems that puzzled even the district technician.

> Last week I was in Chicago for service training. . . I am already seeing some of the benefits from the trip. I have already solved a problem that the (district) technician could not solve (WL, April 29, 1987).

To deal with the jamming of the printers, the noise level, and the loss of class time for printing, many teachers adopted rules for use of the printers, restricting who could operate the printers and during what time periods. Several teachers tried having the students save their work onto one data disk and then printing all the student work at the end of the day. In some classrooms, teachers secured additional printers to alleviate the backlog of printing jobs and continued to have students do their own printing.

Securing additional equipment was the obvious solution to many of the teachers' complaints about lack of equipment. As they received additional equipment, the teachers reported favorable improvements in their classroom environments.

> Some of the special education equipment is here, and we have home computers and monitors. In the classroom, we have a screen projection system which I am excited about using. We also will be working with National Geographic. So things are looking up for us (AT, Sept. 18, 1987).

> Thanks again for the update 2.0. We have been appreciating and using the network even more this year. We now have MacPluses at the work stations. The MacPlus along with the SE's as file servers are fantastic! The access time is so short that we never even think of access time like we did last year (WL, Feb. 25, 1988).

However, as one teacher pointed out, the increases in equipment brought increases in expectations.

> If we go way back, I wanted one computer for my class, then when I got one I wanted two and then 15 and so on. Well, now we have one laser player and one scanner and already the kids are standing in

> line to use them. We have one 20 meg hard drive, and it is filled up and no longer useful in Hypercard. We need a bigger storage unit. . . It just seems that what you've got is never enough (AT, March 8, 1988).

As the teachers became accustomed to the new technology, they gradually adjusted to the changes in the classroom environment. By increasing their knowledge, they enhanced their abilities to manage these high-access-to-technology classrooms. One teacher regularly attended a computer applications class taught by a colleague in the school, and another teacher began an individual study program to learn how to type correctly. Many teachers spent their summers becoming more familiar with the software already being used by the students and previewing new software. Through the process of preparing for and teaching their classes, the teachers learned new techniques and applications which enhanced their instruction the following year.

> I'm feeling really good about the things I've found out this year for ways to use the computer in instruction, and I'm looking forward to working it in as I make my lesson plans this summer. I can take an introductory idea and expand it into Hypercard, for instance (AT, June 2, 1988).

Just as increased knowledge aided the teachers, substitutes and parents benefitted from learning more about using computers. By holding parent meetings, the teachers could help parents feel more comfortable about supervising their children's homework on the computer. Similarly, substitutes who participated in computer training workshops became both capable and eager replacements in the ACOT classrooms.

> The substitute teachers were not only unafraid to (work with the students and the computers), some of them requested that they be given the opportunity to do so. I was a little surprised, but very pleased! We have frequently invited the subs to participate in workshops, and it seems to have paid off (WL, March 7, 1987).

Increased teacher knowledge also had a noticeable impact on student engagement, lessening discipline problems that had plagued teachers during the beginning of the project. For example, one elementary teacher discussed her surprise at how well she was able to conduct a lesson on Appleworks during her second year with the project:

> Today, being on task was not a problem. . . I was absolutely amazed at how easy Appleworks was for the children. . .The kids' eyes were just glued to the computer screen. . . Last year, I wasn't that familiar with Appleworks and wasn't positive what the next screen would be. This year, I could teach it confidently. As a teacher, you need to be in control at all times with these students and if you're unsure of the software the children can sense it and chaotic moments can happen (AT, Aug. 18, 1988).

By the second year of the project, reports of increased student engagement and motivation were common. Students began to come into the classroom to work at lunch time and after school, and began to complain when they were sent out for recess. Such positive changes in student engagement not only surprised ACOT teachers but other teachers as well. One high school teacher reported:

> Sharon said that other (non-ACOT) teachers saw her gathering up materials in the library during the first week of May and asked her what on earth she was doing. Most of the other teachers were beginning to wind down and the ACOT teachers were still beginning new projects. The students showed no signs of quitting either - so the education process just kept humming along (WL, June 7, 1988).

The computer centered instruction eventually led to different instructional goals for many of the teachers. They viewed instruction in terms of larger goals and worried less about whether they were teaching a specific content to the students.

> I think that if you're going to make use of technology, you have to let go of having to cover specific material, from a specific book, by a certain time. I'd like to be free of these constraints. I have some proposals for next year (AT, Sept. 16, 1988).

Some features of the new classroom environment, which troubled teachers initially, became less important to the teachers. They began to accept the necessity for students to move freely around the classroom and became less bothered by the noise level. One teacher went so far as to say,

> I love to hear the sound of the computer keys as they (the students) work. ACOT classrooms do have different sounds, don't they? (WL, March 8, 1989)

Summary

Although the teachers in this study were initially overwhelmed with unexpected problems brought about by the introduction of technology to their classrooms, data suggest that they quickly rebounded and became adept at problem-solving. To combat student misbehavior, they restricted computer access and used the technology as a motivational tool. To save themselves time, they used the students as resources, and became more comfortable with the idea that their students were sometimes the experts. They found ways to organize the room to create a better working environment, and obtained resources to eliminate problems caused by glare, chalkdust, or poor weather. While problems with the software and hardware never completely disappeared, teachers began to take pride in their ability to troubleshoot and repair the equipment, in their knowledge about the technology, and in their ability to change plans when last-minute problems arose. As teachers became more knowledgeable about and confident with the technology, they witnessed positive changes in student engagement and motivation, further decreasing management problems.

Stage Three: Impact

In the final stage, impact, the teachers utilized the technology to their advantage in managing the classroom. Rather than just troubleshooting, the

teachers developed techniques for monitoring student work, keeping records, grading tests, developing new materials, and individualizing instruction. As the teachers learned more about computers and software, they discovered that the technology could save them time rather than creating additional demands.

> I came into the program with a negative attitude about technology complicating things and being more of a hassle than it is worth. Even today when my disk failed and I spent a half-hour saving the data, I have come around to the idea that technology intelligently used can simplify one's life and free up time and energy for other things (AT, October 24, 1988).

One of the first areas where teachers learned to utilize the technology to their advantage was recordkeeping. By creating databases and spreadsheets on the computer, the teachers significantly decreased the amount of time they spent keeping track of everything from teaching materials to grades. After the teachers started using databases, they uncovered more and more applications.

> I mentioned to (another teacher) yesterday how much I love databases. It seems like a silly thing to say to somebody, but I do. I didn't realize when I was department chair that when I was doing organizational work, I was creating databases. I was always drawing little grids or charts to keep track of things. I didn't do it as much as I would have because they were so laborious to create. But now I create them for everything (AT, November 4, 1988).

In one classroom, the students created a database that included all of the software they had used or heard about for the Macintosh. In about 20 minutes, the students had created the database and rated the software. The teacher envisioned that the database would help teachers evaluate future software purchases. Another teacher, who previously had created spreadsheets which calculated the amount of money each child brought in from the fundraising campaign, decided to develop spreadsheets for students to use in keeping track of their scores on assignments.

> It (the spreadsheet) automatically calculates their percentage correct and sets a marker if their percentage is below 80%. Students then have to complete as many more problems as they need to in order to reach 80% (WL, May 1, 1987).

In addition to using spreadsheets for their master records, teachers created modified versions that the students could access to verify their progress. This eliminated the need for students to question the teacher individually.

The computers also proved to be a great boon when it came time for the teachers to calculate grades. Some teachers used commercial grading programs while others developed their own. In either case, the prime benefit was the reduction in the time needed to compute and record grades.

> Figuring out grades for my 60 students was much different than in the past. . . It took me only 30 minutes instead of six hours or more. This program allowed me to juggle with the weighting of the grades. . . . I now post grades every Friday because it's so easy to do the grades (AT, Nov. 9, 1987).

> I only had to go around the room and enter the test grades into my spreadsheet to average the whole year's grades. That really saved time, and the whole year's grades are done (AT, June 9, 1988).

For the special education teachers, one of the most time consuming tasks was preparing the required IEP's (Individual Education Plan) for each student. After some trial and error with different formats, one site developed a workable form that could be used by special education teachers to simplify the process.

> We have been busy preparing for the IEP conferences. . . It has been another new adventure for us since we have never used computerized IEP forms before to show parents and ourselves where the students are at and the areas they need to work on. . . Once I figured out a way to evaluate the students in language, I began feeling very positive toward the whole process. . . Since we are using the computer program . . . writing the IEPs is not the chore I used

> to hear the special ed teachers complaining about. Hurray for High Tech!!!! (WL, March 13, 1987).

As the teachers shared their ideas with one another and experimented with the computers, they came up with improved techniques for developing assignments and tests. For example, teachers could type assignments directly into the network rather than running off separate assignment sheets.

> In physical science, Steve is downloading his templates on chemical reactions he developed last year...the students have access to the total assignment on the network and are working through it much more quickly and with more understanding. Many of them never used paper and pencil on the assignment at all. They download Steve's handouts to their computers, work on the tasks assigned, and send the final copy of their work to the printer to be picked up by Steve. No more pages and pages of handouts that are lost, replaced, and lost again (WL, May 4, 1988).

The computer also made it easier for teachers to discourage cheating by making three or four different forms of a test.

But one of the main advantages was the immediate feedback for students on both tests and assignments.

> Recently I gave a science test and students were able to get results within 15 minutes of completion. . . There's nothing like immediate feedback -- not to mention the amount of time saved (WL, Sept. 16, 1987).

One teacher, Carol Jones, came up with a format that used immediate feedback to help students "discover" mathematical concepts. For instance, in an algebra lesson on factoring trinomials, the students were asked to put in values for the designated variables. The computer responded with either a "not valid" or "this is it" message. The purpose of guessing the values was to help students understand the significance of the middle term.

> The students were catching on to the fact through trial and error that the middle term was really important in coming up with the correct factors. That sometimes slips by them when each student does not have the opportunity to have immediate feedback (WL, April 27, 1989).

Besides providing immediate feedback to students, the technology allowed teachers to update their tests and materials on a frequent basis. For example, Jane Jenkins used the morning newspaper to create "current events" assignments for her classes that day.

> I can put together a newspaper assignment for my first period very quickly. Twenty minutes before class, I skim the newspaper and make up assignments that are pertinent to today's news. It's really no great effort with the Macintosh (AT, March 29, 1987).

The computers also enabled the teachers to individualize instruction in many of the subject areas. Students could work through the material at their own pace because the technology made it possible for teachers to manage the range of instruction.

> The individualized math program has been my greatest success this year. My children are doing so well in math and are doing it at their own level. . . We've been using the MECC software as a back up for each of the objectives. I feel really good about the math (AT, Feb. 28, 1989).

In addition, the computer facilitated reteaching and retesting of select students because it could generate both tests and study guides.

As the teachers became more familiar with computer applications and software, they developed strategies for increasing the amount of material they could cover during the school day. For instance, math teachers reported that they had been able to cut back on the school time spent on arithmetic skills, relying more on computer homework for arithmetic and spending the school time on problem solving. A science teacher, who formerly spent ten complete

class periods on a biology lesson about DNA modeling, used the drawing feature of the computer to design a similar lesson that required only 40 minutes of class time. An elementary teacher commented how letter writing was so much easier to teach on the computer because of the editing feature. With less time being spent on basic topics, the teachers could enhance and improve their curriculum.

> Academically, I have to add things to the curriculum to make it more challenging. The computer is a tremendous help in this area (AT, Oct. 12, 1988).

Changing attitudes accompanied the changes in the teachers' abilities to utilize the technology to their advantage. Whereas teachers earlier worried about the classrooms becoming technology- centered rather than instruction-centered, they now described the classrooms as more learner-centered.

> The set-up in ACOT makes it possible for the classroom to be more learner-centered than teacher-centered. I find myself being more of a facilitator. I am sure that I will change even more as I learn new techniques (WL, April 27, 1989).

They no longer viewed the process of learning to use the computers as infringing on the curriculum. Instead, they described the technology as "support for the curriculum." One teacher, who developed techniques for using laser video discs and animation in his biology materials, suggested that "the content is the same, but how we deliver it is completely different (AT, Nov. 4, 1988).

This difference in the delivery of the content translated into increased student interest and attention. Teachers now were able to use the technology to enhance student motivation and interest while decreasing the number of discipline problems. Students spent more "time on task" and even asked for additional work on the computer.

> One of our visitors asked if the students every get tired of the computer. I answered that they get tired of doing the same thing but that they don't get tired of working on the computer. They actually ask for

> things to do.In all my years of teaching, I never had anyone ask for another ditto (AT, March 17, 1988).
>
> I also believe that when the students are working on the computer, they are able to stay on tasks longer (AT, Oct. 12, 1988).
>
> I am also noticing the deep concentration apparent when they get to use the computers. Amazing how they can stay on task for so long -- even with visitors present (AT, March 22, 1988).
>
> It's so interesting to see how motivated the kids are to use the computers. What is it about the computers that does this? (AT, March 25, 1988).

The increased student motivation extended beyond the classroom. A ninth grade student surprised her teacher by sharing a tip that she had read in a computer magazine the night before.

> When the laserwriter is first ready, it prints a warm-up sheet. One of our 9th graders came over and told (the teacher), 'If you pull the paper tray out just a little before you turn on the printer you can save the sheet of paper. I read that tip in the new issue of Macuser last night' (WL, Jan. 23, 1988).

Besides increased interest, the students exhibited more pride in their work. With the graphics capabilities and the printer, the students enjoyed producing assignments that "look so good." They also enthusiastically shared their latest discoveries on the computer. When a new software program was introduced in one classroom, the students, rather than asking questions, started exploring on their own.

> I was immediately mobbed, as were (the other teachers), not with inquiries for help as might be expected with the introduction of new software, but rather with pleas to see what each of them had discovered on their own. It was one of the most exciting times we've had in our classroom this year (WL, April 29, 1987).

As the teachers became less threatened by some students' exceptional abilities on the computer, they reframed their views about teacher role and used these students as peer teachers. This made it possible to provide more individual help to students who were experiencing difficulties. One teacher developed an assignment that required the students to not only solve a problem but to also design a system for helping other students with that particular problem.

> The students convert solutions to some chemistry problems into HyperCard. The idea is to design a "HELP" stack for someone who might have trouble solving that particular problem. The students share the solutions with the rest of the class and then save them on the network for others to use should they need help later (WL, Feb. 15, 1989).

Besides allowing students who were more knowledgeable about the technology to teach their peers, the teachers themselves drew upon these students' expertise when problems occurred.

> How do you navigate in fat bits (on Hypercard)? The documentation does not show you how to do this. The kids showed me how to use the program, and it's good to have someone who can help me use the programs (AT, Feb. 12, 1988).

As the teachers learned how to utilize the technology to their advantage in managing the classroom, they discovered that their attitudes about computers changed. In contrast to the beginning of the project when the teachers expressed concerns about their "computerized classrooms," the teachers now worried about having to teach in classrooms without high-access to technology.

> The power was not working in our classroom, and we had no computers. But the class had to go on. We had to go back to the good old days of pencil and paper. It was so strange not hearing the computer go on and not hearing the keypads going. . . I had the feeling I was in a different classroom, and I didn't like that classroom (AT, Oct. 11, 1988).

> Now I believe, like many other teachers who have discovered the same thing, that it would be hard to live without a computer. . . It has become a way of life (AT, Sept. 9, 1988).
>
> That computer has become so much a part of my body that I just don't seem to be able to work without it (AT, Sept. 13, 1988).

The teachers had moved past the survival and mastery stages to a point where the technology had an important impact on their teaching. Although some problems could never be eliminated completely, the benefits significantly outweighed the drawbacks.

CONCLUSIONS

Two decades ago, researchers studying teacher development found that preservice teachers' concerns progress through a series of stages. When first entering the classroom, teachers focus on themselves, and are concerned about such issues as controlling student behavior. Eventually, however, they become increasingly concerned about their impact on such variables as student achievement and attitude.

These stage models of teacher concerns have been expanded to include teachers who are exposed to educational innovations. As was the case with novice teachers, studies examining educational innovation have found that teachers' concerns also go through developmental stages. Teachers appear to progress through these stages in an idiosyncratic manner, and may express concerns in more than one stage simultaneously.

Consistent with the stage theories proposed by researchers such as Fuller (1969), and Hall and Loucks (1979), the data gathered in this study support the notion that teachers working in high-access-to-technology classrooms also move through three stages of concerns in regard to classroom management: survival, mastery, and impact. Classroom management is a skill that cannot be mastered once and for all. Changes in the classroom environment can significantly alter the success of a teacher's "tried and true" principles. The 32 ACOT teachers, though primarily experienced teachers, discovered that managing a high-access-to-technology classroom was

significantly different from many of their previous experiences. During the survival stage, they felt overwhelmed by their inability to anticipate problems, and consequently, they often were unable to make necessary changes when problems did occur. With experience, however, they began not only to anticipate problems but to develop strategies for solving and avoiding them, and thus entered stage two, mastery. The most significant changes occurred when teachers moved beyond the survival and mastery stages to the third stage, impact. By this point, teachers focused on the effects of their teaching on students and began to utilize the technology to their advantage in managing the classroom. Teachers used the technology to enhance student motivation, interest, and learning as well as to decrease discipline problems. They incorporated the technology into their teaching in such a way that they now couldn't imagine teaching without it. Teaching in a high-access-to-technology classroom had become a beneficial "way of life."

IMPLICATIONS

As countless other studies investigating innovation point out, educational change takes time. Data from this five-year study demonstrate that, even when classroom environments are drastically altered and teachers are willingly immersed in innovation, change is slow, and sometimes includes temporary regression. Unfortunately, agencies or organizations funding innovative programs often expect to see measurable "progress" or "success" within one year of funding. If ACOT had only been funded for such a short period of time, and if teachers had not had the time to move into the mastery and impact stages, it would have been easy to conclude that education is not ready for high-access-to-technology environments. This study therefore illustrates the importance of investigating innovation longitudinally. Teachers need to have time to move through different stages of concern in order to utilize technology, or any innovation for that matter, to their advantage.

Moreover, those searching for a way to assess the impact of innovation should not expect to see a clear progression through stages. Problems of implementation and adoption may arise, disappear, and then reoccur as teachers and students adjust to the innovation.

The Apple Classrooms of Tomorrow project, from which this paper stems, was created for the purpose of simulating future educational environments. Five years of experiences in these futuristic settings provide a basis for beginning to understand the impact of technology on classroom management. As schools begin to use more technology in the classroom, teachers will benefit from the insights of the participants in these experimental settings, perhaps avoiding the problems these teachers have identified. This study can also inform teacher educators so that future generations of teachers are more fully prepared to utilize available resources and technology.

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